

Etching Detritus Capture and Reduction Method for Reducing Water Consumption in Microchip Manufacturing

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Simon Edwards

Research Acceleration Initiative

Introduction

Semiconductor microchip manufacturing consumes large quantities of water, not only putting a strain on water tables (particularly in semiconductor manufacturing centers such as Arizona,) but increasing the cost of chip manufacture and increasing the length of time it takes to produce processors.

Water is used in abundance in semiconductor manufacturing as a result of the need to repeatedly and thoroughly wash chips of the detritus associated with LASER-etching circuit patterns into chips. This detritus is composed both of paramagnetic materials which might be removed magnetically and non-magnetic materials, sc. the residue of photoresist applied to the wafers prior to the etching process. This seemed to rule out the use of magnetic fields for the capture of etching detritus, leaving only the use of water or the use of “dry” chemical-based buffing methods for the removal of detritus which would interfere with subsequent fabrication steps if not removed between each step.

Abstract

As photoresist’s optical properties must already be compensated for by the optical systems used in fabrication, with some additional adjustments, it should be feasible to perform photofabrication with the chip submerged in a small quantity of pure water whereas the amount of water is controlled precisely in order to ensure that the optical effects of the water are not so great that fabrication is disrupted.

The water would be rendered as positively electrically charged. The LASER pulses used in fabrication create superheated detritus which has a negative electrical charge. By carrying out the fabrication under a millimeter’s thickness of pure water, provided that it is strongly positively charged, adhesion of the particles generated with the wafer is prevented and the detritus is captured in the water. Provided that a novel photoresist is used which incorporates a paramagnetic component, a powerful magnet could be used to remove both the semiconductor material and the photoresist from the water.

If we use the metaphor of cleaning a surface such as a kitchen table quickly before soil becomes encrusted, it is easy to understand why it is easier to clean something before soil can “set in.” If that kitchen table is submerged in water, there is never any opportunity for contaminants to adhere in the first place.

As it takes only a fraction of a second for photoresist and semiconductor metals to become affixed to a wafer, the submersion of the chip in a small

quantity of positively charged water prior to and during the etching is the best way to prevent this adhesion.

After the contaminants captured in the water are extracted using a powerful magnet, subsequent steps may be performed, re-using the same, small quantity of water again and again.

Conclusion

This approach would not only reduce financial cost and water consumption, it would reduce pollution of the water tables (as these contaminants are usually disposed of along with wastewater) and would allow for a greater portion of the semiconductor material to be reclaimed for future wafer production. So long as the magnetically-active photoresist and the semiconductor require different amounts of magnetism in order to attract them, separating the photoresist residue from the semiconductor metals shouldn't be much more complicated than reducing the power of the magnet to release the photoresist while the magnet is held over one bin and deactivating the magnet over a separate bin.